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FOREIGN TECHNOLOGY DIVISION

DATA ON THE STUDY OF BACTERIAL CONTAMINATION OF ATMOSPHERIC AIR OF THE CITY OF ODESSA

by

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EDITED TRANSLATION

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DATA ON THE STUDY OF BACTERIAL CONTAMINATION OF ATMOSPHERIC AIR OF THE CITY OF ODESSA

O. Yu. Grigorashchenko and L. M. Kharmats

During the years 1956-1960 the bacteriological laboratory of the city of Odessa conducted systematic investigations of the city's atmospheric air and bacterial contamination. Air samples were taken with the aid of Krotov's aspiration apparatus using such subsistence media, as meat-peptone agar, blood agar, and Wilson-Blair or Endo medium for the detection of bacteria of the intestinal group.

Within five years 41,516 samples of atmospheric air were investigated, which are divided by years in such a manner: in 1956 - 4032, in 1957 - 7648, in 1958 - 9688, in 1959 - 9312 and in 1960 - 10,836.

Comparisons of materials obtained by us from eight points show that the quantity of microorganisms in atmospheric air fluctuates considerably. The greatest air contaminations were found over the central sections of the city close to the market place (points No. 1a and b), especially during the period from 8:00 to 9:00 in the morning, when the movement of vehicular and pedestrian traffic is the heaviest; in the industrial section of the city (point No. 3); in the region of the harbor (point No. 5) and in the region of the railroad freight station (point No. 6).

In the air of the city park (point No. 7) and in the residential seaside region (point No. 4) the quantities of microorganisms were

much lower. The special exception is point No. 8 (control), where during an entire year the quantity of microorganisms was the lowest. This is the southern region of the city, a basin which overlooks the sea. Here you will find plenty of vegetation, higher humidity of the air, and an absence of dwellings, vehicular traffic and pedestrians.

A comparison of the data obtained in various seasons shows that the fewest microorganisms in the air were found in the winter months and the largest quantities in the summer months. And so, since in winter the average quantity of microbes in 1 m^3 of air varied from 100 at point No. 8 to 2300 at point No. 5, the summer fluctuations were from 524 microbes at point No. 8 to 5993 at point No. 6 (Table 1).

Along with this it is necessary to point out the effect of atmospheric precipitations on the presence of microbes in the air. The quantity of microorganisms in atmospheric air in rainy weather decreases by two, three and even four times. This phenomenon is explained by the fact that, on the one hand, under the effect of rain rapid precipitation of the aeroplankton from atmospheric air takes place, and on the other hand, the humid ground in the meantime ceases to be a source of dust and as it were fixes microorganisms on itself.

The reduction in the quantities of microorganisms in the air in the winter is related to the low temperatures of the air and ground, their higher humidity and under the conditions of the city of Odessa, by the periodic presence of a snow cover.

In summer the bacterial contamination of the air is 1-1/2 to 2 times higher than in spring and in the fall perhaps three times higher than in winter. This is essentially due to meteorological factors, especially to the number of atmospheric precipitations, the relative humidity and the temperature of the air. Under the conditions of the city of Odessa in summer, although there is a relatively great quantity of atmospheric precipitations, they are all of torrential nature at this time. Most frequently such rains fall in June; then in July and August there is dry and hot weather with frequent gusts of winds, which promotes intensive pollution of atmospheric air and, simultaneously, its bacterial contamination.

Table 1. Degree of contamination of atmospheric air by seasons during the years of 1956-1960.

Number and total characteristics of the point	Winter				Spring				Summer				Fall			
	Average amount of microbes per 1 m^3 of air		Sporiferous aerobes from them		Average amount of microbes per 1 m^3 of air		Sporiferous aerobes from them		Average amount of microbes per 1 m^3 of air		Sporiferous aerobes from them		Average amount of microbes per 1 m^3 of air		Sporiferous aerobes from them	
	clear weather	rain	clear weather	rain	clear weather	rain	clear weather	rain	clear weather	rain	clear weather	rain	clear weather	rain	clear weather	rain
1a. Center of city, market place.....	1646	698	275	68	2576	1065	348	108	5675	1441	1164	285	3994	1584	528	143
1b. The same.....	1287	725	148	132	2483	850	436	115	3295	1342	520	276	3062	1487	304	166
2. Center of city, inhabited sections	1172	383	175	120	1017	434	201	63	2238	1465	555	258	1431	720	270	30
3. Industrial region of the city.....	1565	405	248	175	2875	860	540	248	2173	1969	1600	402	3698	1055	759	151
4. Residential seaside region.....	764	187	241	51	1128	339	264	76	1652	493	334	63	1299	510	196	85
5. Region of the harbor.....	2300	920	903	140	2241	1333	395	184	4217	1963	884	783	4271	1361	1007	297
6. Region of R/R freight station.....	1799	534	417	273	2215	1062	731	412	5993	1397	1197	175	3960	2021	558	422
7. City park.....	547	246	87	48	430	201	80	42	1470	425	528	142	1820	282	692	78
8. Control; greenery-covered suburban part of the city.....	100	14	13	7	232	71	50	16	524	161	66	26	544	109	136	24

Meteorological data for an average of five years (1956-1960)

Temperature of the air.....	—0.6°	9.1°	21.2°	9.7°
Relative humidity.....	82.5%	75.0%	70.0%	75.0%
Wind speed.....	5.4 m/s	5.3 m/s	3.8 m/s	4.6 m/s
Barometric pressure.....	760 mm	758.3 mm	756.1 mm	761.3 mm
Atmospheric precipitations....	89.6 mm	82.5 mm	134.5 mm	106.0 mm

The quantity of microorganisms in the atmosphere above the city is in direct dependence upon the temperature of the air – the higher the temperature, the more microbes are found in it (Table 2).

Under the conditions of the city of Odessa such months as July, August, and September are the driest ones. A small amount of atmospheric precipitation in connection with high air temperature in this period favors a considerable rise in the quantity of organisms in the air. In the summertime also added to these factors is that of the rapid drying of the upper ground layers, as a consequency of which the dust together with microorganisms enter the air.

The quantity of sporiferous bacteria also depends upon the time of year and the meteorological conditions (see Table 1). Here it should be noted that in the city, for the entire time that our observations lasted, large-scale ground works connected with the building and expansion of underground utilities were being carried out (waterworks, sewage system, gasification, thermofication, communication, electrification, etc.). These microbes were compulsory representatives of the bacterial aeroplankton in the air samples, gathered at all eight points of the city.

Table 2. Average monthly indexes of bacterial contamination of the air for the city of Odessa by months (1956-1960).

Month	Absolute average values of microbe quantities in 1 m^3	Contaminations compared with January, %	Month	Absolute average values of microbe quantities in 1 m^3	Contaminations compared with January, %
January....	1084	100,0	July.....	2801	258,3
February...	1190	111,4	August.....	2938	271,1
March.....	1214	112,0	September..	2977	274,6
April.....	1966	181,3	October....	2467	228,2
May.....	2193	201,1	November...	1700	156,7
June.....	2558	235,9	December...	1136	104,1

A cocoon group of microorganisms – staphylococcus aureus and a relatively small quantity of hemolytic staphylococcus – was isolated, especially, at the end of spring, in the summer, and in the beginning of fall, i.e., in the warm period of the year.

Of special interest, in our opinion, are the isolations of representatives of the intestinal group of bacteria.

Within the five years 784 strains from that group (Table 3) were isolated.

Table 3. Quantity of intestinal group bacteria in atmospheric air for five years (1956-1960).*

No. & general characteristics of the point where sample was taken; sample taken for 1 h.	Periodicity of taking samples	Total amount of microbes in 1 m^3	No. of them - intestinal, paraintestinal bacilli & B. faecalis alcaligenes	% of the overall quantity of bacteria
1a. Center of the city, market place, at a height of 1.7 m, 0800 hours.....	Daily	17576	249	1,4
1b. Same, at 1800 hours.....	"	12429	88	0,7
1b. Same, at a height of 25 m at 0800 hours.....	"	15540	152	0,9
1b. Same, at 1800 hours.....	"	10234	46	0,4
2. Center of city, residential quarters.....	"	4887	10	0,2
3. Industrial region of the city	"	12297	71	0,5
4. Residential seaside region	"	4622	66	1,4
5. Harbor region.....	Weekly	6726	23	0,3
6. Region of R/R freight station.....	"	15506	28	0,1
7. City park.....	Daily	3940	40	1,0
8. Control, greenery suburban zone.....	Weekly	1286	—	—

*In addition to the bacteria mentioned in the table, at points Nos. 1a, 1b, 3, 4, and 7 we isolated seven strains of bacteria of Flexner dysentery; at point No. 1b - one strain of Newcastle dysentery bacteria; at point No. 4 - one strain of Boyd-Novogrodsky bacteria; at point No. 1a - two strains of Morgan bacillus. Exciters of Flexner dysentery belonged to three types c-3, f-3, a-1.

**At this and at the remaining points samples were taken from 1000 to 1200 hours at a height of 1.5 m.

Intestinal, paraintestinal bacilli and *B. faecalis alcaligenes* in atmospheric air were found mainly at points Nos. 1a and b, 4 and 7, which may be explained by the great pollution of these areas. At point No. 8 during a period of five years representatives of the intestinal group could not be isolated, which is explained by the considerably more favorable climatic and sanitary conditions of that area.

Table 4. Quantity of detected strains of intestinal bacteria as a function of the season of the years (1956-1960).

Year	Time of year	Intestinal bacillus	Paraintestinal bacillus	B. faecalis alcaligenes	Morgan bacillus	Dysentery bacilli: Flexner	Dysentery bacilli: Newcastle	Dysentery bacilli: Boyd-Novgorodskaya	Total
1956	Winter	No investigations were made							
	Spring	40	2	1	—	3	—	—	46
	Summer	17	9	5	—	2	—	—	33
	Autumn	2	1	—	—	—	—	—	3
Total for 1956		59	12	6	—	5	—	—	82
1957	Winter	7	6	3	2	—	—	—	18
	Spring	10	6	3	—	—	1	—	20
	Summer	13	7	2	—	—	—	—	22
	Autumn	40	12	5	—	1	—	—	58
Total for 1957		70	31	13	2	1	1	—	118
1958	Winter	14	8	1	—	1	—	—	24
	Spring	11	8	2	—	—	—	1	22
	Summer	19	20	2	—	—	—	—	41
	Autumn	29	16	6	—	—	—	—	51
Total for 1958		73	52	11	—	1	—	1	138
1959	Winter	4	1	—	—	—	—	—	5
	Spring	26	6	—	—	—	—	—	32
	Summer	34	11	1	—	—	—	—	46
	Autumn	64	15	—	—	—	—	—	79
Total for 1959		128	33	1	—	—	—	—	162
1960	Winter	35	25	7	—	—	—	—	67
	Spring	29	16	5	—	—	—	—	50
	Summer	71	17	6	—	—	—	—	94
	Autumn	60	10	3	—	—	—	—	73
Total for 1960		195	68	21	—	—	—	—	284
Total for 1956—1960		525	196	52	2	7	1	1	784

As for the dependence of the quantity of bacteria of a given group upon the seasons of the year, as is evident from Table 4, in the winter and early spring they were much less numerous in atmospheric air than in the summer and fall.

All types of dysentery infecting agents, with the exception of one, were isolated in the spring, summer and fall, and the Morgan bacillus was isolated in two instances in the winter time.

Strains of the intestinal group revealed by us, as well as representatives of general microflora, managed to get into the air

together with ound dust. And so, the detection of bacteria of Flexner dysentery at point No. 7, in the city park, involved the fact that at a distance of 50 m from the spot where the air sample was taken there was a rest room.

Of the total quantity of 784 strains of intestinal group bacteria the strains of intestinal bacillus constituted 525. It is necessary to mention that the majority of them, isolated from atmospheric air in the cooling period, did not ferment saccharose.

Additional investigations were conducted on all the strains of intestinal bacillus. A test was made with methyl red, a Foges-Proskauer reaction, and a citrate test and the ability of wading through handfuls of an Eichmann medium was examined; an agglutination reaction was made with coli-serums. Four strains of 0-26, five strains of 0-55, and 15 strains of 0-111 were isolated. Of these 24 strains 17 were agglutinated by Flexner serum, three of which were typed as monoreceptorial serums.

The data obtained during the period of dust storms in March and April 1960 appear to be of special interest. The microflora of the air in the city thus changed abruptly. The quantity of microorganisms in 1 m^3 of air was several times greater than at these same points after the dust storm. During the storm pigmental microorganisms (staphylococci and Sarcina) disappeared. The quantity of sporiferous aerobes, which composed the basic mass of colonies, sharply increased and the colonies grew.

According to data of the local hydrometeorological observatory, dust storms started in March, and then recommenced in April of 1960 in the Stavropol'and Kuban' regions, they succeeded in expanding on the shorelines of the Azov and Black Seas, and enveloped the Ukraine. The height of a dust column reached 2-2.5 km. In the period of greatest amount of dust in the air (April 7, 1960) horizontal visibility was reduced to 200 m (as compared with 10 km in normal weather).

The data given in Table 5 attest to the fact that the microflora of the air in the examined region changes sharply and that the bacteria

and fungi found in the air can be carried great distances from their various locations with their geographical dispersions.

Table 5. Quantity of microorganisms before, during and after the dust storm.

Place and time of sample taken	Average quantity of microorganisms in 1 m^3 of air			
	before & after dust storm		during the dust storm	
	Total amount of microbes	Sporoiferous aerobes	Total amount of microbes	Sporoiferous aerobes
1a, at 0800 h, hgt 1.7 m..	1480—3360	300—800	10986	8426
1a, at 1800 h.....	1306—3200	666—853	23680	21733
1b, at 0800 h, hgt 25 m...	1120—2826	313—563	14800	12266
1b, at 1800 h.....	840—933	200—413	11573	8083
3	3406	645	14613	10453
4	810	294	10773	7953
7	410	257	11623	9280
8	129	91	9653	4190

At control point No. 8, spreading, as was shown above, into the suburban zones, where there is much vegetation and higher air humidity, the quantity of microorganisms in the air at the time of the dust storm was lower than at other points.

Conclusions

In the air of the city of Odessa, together with the normal microflora (asporogenous and sporogenous) a considerable quantity of intestinal microbes was found. Of 784 strains of that group seven strains of Flexner dysentery bacilli, one strain of Newcastle dysentery bacillus, and one strain of Boyd-Novogrodsky dysentery bacillus were differentiated, which may be of certain epidemiological importance.

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Summary

During the years 1956-1960 the city bacteriological laboratory of Odessa conducted systematic bacteriological investigations of atmospheric air. Air samples were taken by means of a Krotov apparatus and by the precipitation method at eight points in the city of Odessa. The largest content of microorganisms was observed at points Nos. 1, 3, 5, and 6. In winter the quantity of microbes in 1 m^3 of air was considerably lower than in summer. During rainfall or snowfall the number of colonies was two, three, or even four times less than the standard quantities in dry weather.

Attention is drawn to the fact that 784 strains of representatives of the intestinal group of bacteria were isolated; of them 7 were Flexner's dysentery bacilla, 1 was a Newcastle dysentery bacillus, 1 was a Boyd-Novogrodsky dysentery bacillus and 2 were Morgan's bacilli. Of the 524 isolated strains of intestinal bacilli, 24 were agglutinated with *O-coli*-serums, 17 of them with Flexner's serum.

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ABSTRACT (UNCL, 0) AUTHORS SUMMARY OF REPORT. During the years 1956 to 1960 the city bacteriological laboratory of Odessa conducted systematic bacteriological investigations of atmospheric air. Air samples were taken by means of a Krotov apparatus and by the precipitation method at eight points in the city of Odessa. The largest content of microorganisms were observed at points Nos. 1, 3, 5, and 6. In winter the quantity of microbes in 1 m super 3 of air was considerably lower than in summer. During rainfall or snowfall the number of colonies was two, three, or even four times less than the standard quantities in dry weather. Attention is drawn to the fact that 784 strains of representatives of the intestinal group of bacteria were isolated; of them 7 were Flexner's dysentery bacilla, 1 was a Newcastle dysentery bacillus, 1 was a Boyd Novogrodsky dysentery bacillus and 2 were Morgan's bacilli. Of the 524 isolated strains of intestinal bacilli, 24 were agglu tinated with O coli serums, 17 of them with Flexner's serum.